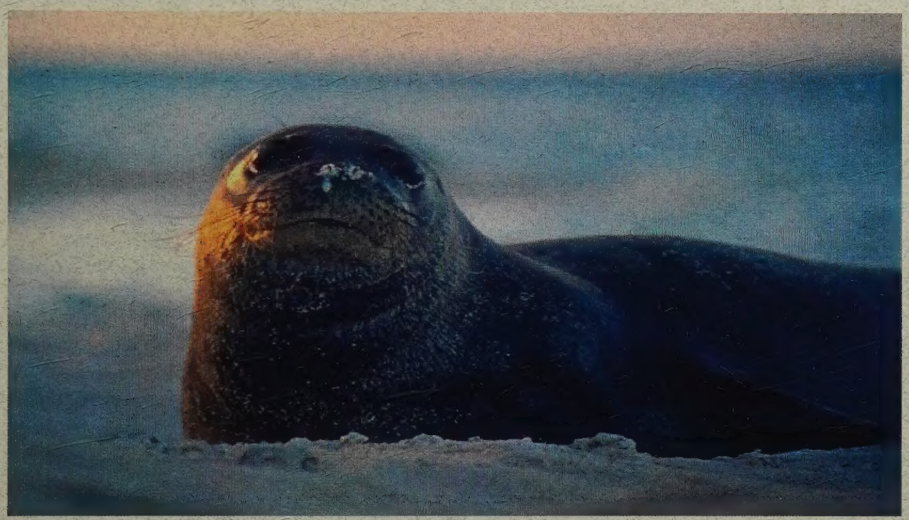
NOAA Technical Memorandum NMFS-PIFSC-18

March 2009

Clinical Observations of Ocular Disease in Hawaiian Monk Seals (*Monachus schauinslandi*)



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Hanson, M. T., A. Alonso Aguirre, and R. C. Braun.
2009. Clinical observations of ocular disease in Hawaiian monk seals (*Monachus schauinslandi*). U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-18, 9 p.

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Clinical Observations of Ocular Disease in Hawaiian Monk Seals (*Monachus schauinslandi*)

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INTRODUCTION

The Hawaiian monk seal (*Monachus schauinslandi*) is geographically located in the Hawaiian Archipelago and considered the most endangered pinniped in U.S. waters. As a result of a severe population decline, the species has been protected since 1972. In accord with the National Marine Fisheries Service recovery plan, in 1984 a rehabilitation program was initiated to further enhance recovery. Under this program, undersized, weaned female pups from French Frigate Shoals (FFS) in the Northwestern Hawaiian Islands were captured and transported to captive care facilities on Oahu, in the main Hawaiian Islands, where the seals were nurtured over several months to increase their weight, then transported back to the Northwestern Hawaiian Islands for release into the wild (Ragen and Lavigne, 1999).

In 1995, 12 Hawaiian monk seal female pups were captured sequentially at French Frigate Shoals between 27 May and 31 July. At FFS, each seal was held temporarily (generally less than 2 weeks) in a shoreline enclosure and then transported (singly or in pairs) via aircraft to Sea Life Park (SLP), Oahu. The first two pups to be captured and transported (YC03 and YC04) were noted to have eye problems (described as redness, conjunctivitis, and discharge) during the holding period at FFS. Within a few weeks after arrival on Oahu, 9 of the 12 female pups (i.e., YC03, YC04, YC16, YC21, YC22, YC26, YC28, YC33, and YC35) were reported to have initial clinical signs associated with conjunctivitis, red eyes, blepharism, blepharospasm, and photosensitivity. The initial clinical signs seemed to resolve within 2 to 7 weeks of onset. Three pups sampled during this period had a neutrophilia, but other cell blood counts (CBC) and serum chemistry values were normal. Appetite and activity levels were also normal, and no other symptoms were observed.

About 14 weeks after arrival (ca. 4 months after capture), these 9 pups developed corneal opacities associated with transient conjunctivitis, ocular discharge, photosensitivity, "blue eye", edema, and bullous keratitis. The corneal opacities developed centrally and progressed outward to the limbus. In 7 of the 9 seals, opacity and edema developed first in the right eye. Through the course of the disease process, however, opacity and edema progressed similarly and to the same extent in both eyes. Conjunctivitis and photosensitivity occurred transiently after the entire cornea became opaque with a bullous keratitis. At this stage of the disease, vision was severely impaired for about 1 week. Gross examination indicated that the opacities began to recede from the limbus about 50 days after initial detection.

These 9 seals went on to develop cataracts and appeared to be functionally blind between 10 and 15 months after the onset of corneal opacities. Of the 3 seals that did not follow the observed pattern of eye disease described above, only 1 (YC14) remained asymptomatic. Seal YC24 developed mild opacities 10 months after collection (and following a conjunctival biopsy and aqueous humor aspiration), but the opacities almost completely resolved and this seal did not develop cataracts or conjunctivitis. Seal YC32 did not display eye disease until 20 months after collection, when it acutely developed bilateral cataracts. Two of the 9 seals exhibiting the common pattern of eye pathology have died: YC33 died in mid-February 1997 and YC26 died in late March 1997. Necropsies and laboratory investigations indicated

Clostridium perfingens as the cause of death for YC33 (NMFS unpubl. data, 1997). YC26 was diagnosed with fulminating hepatic sarcocystosis (Yantis et al., 1998)

This report describes the clinical signs of ocular conditions that affected these seals during their first 30 months in captivity. Data are presented on the time course and expression of ocular clinical signs and antecedent patterns of social affiliation. Clinical descriptions were based on informal daily reports in each seal's feeding log as well as systematic veterinary observations.

METHODS

Collection and Housing Procedures

After capture from the wild, seals were held 2 to 21 days in a temporary pen by the beach at FFS. The pen, constructed of chain-link fence, was located so that seal pups would have access to fresh seawater and beaching areas. Seals were not housed together at FFS but were sequentially captured and held prior to transport to SLP. The period, from first capture to transport of the last seal to Oahu, spanned 83 days (27 May to 18 August 1995). Most of the seals were held in pairs at FFS; however, two seals were held alone prior to arrival at SLP. Seals were transported using a charter plane to Oahu and subjected to clinical examinations and sampling by the attending veterinarian. At SLP the pups were held in one or more of 4 seawater enclosures. Seals were held in one of two concrete pools (pools A and B) that enabled public viewing. Adjacent to pool A, and out of public view, seals were also contained in a small holding pool (Jacuzzi). Both, pools A and B, and the Jacuzzi had a common water source which was the outflow from a large display aquarium. A chain-link gate separated the Jacuzzi from pool A, and a rock partition separated the Jacuzzi from pool B. The forth enclosure was a 7.3-m diameter fiberglass tank with a water source separate from the pools complex of A and B.

On arrival at SLP, all seals (with the exception of YC24) were held in isolation in the Jacuzzi for a minimum of 11 days. During this separation period, a plywood gate was used to reduce direct contact (through the chain-link fence) between seals in pool A and the Jacuzzi. After a 11-21 day period, all seal pups were moved from the Jacuzzi to pool A. After variable periods of time in pool A, seals were moved either to the 7.3 m tank or to pool B. However, seal YC24 was held in the 7.3 m tank during her first 46 days at SLP.

Between May 1996 and March 1997 the 12 seals were moved to three 6.1-m diameter fiberglass sea water tanks located at the NMFS Kewalo Research Facility (KRF), Oahu. As at SLP, the seals at KRF were periodically moved between specific enclosures to accommodate facility maintenance or to isolate specific individuals for husbandry and veterinary purposes.

Clinical Observations

Daily observations were conducted on the health and feeding behavior of each seal from date of capture and reported in feeding logs. After the onset of corneal opacities in the first 2 seals, a standardized format was developed for describing ocular clinical signs on a biweekly schedule. Specific data were collected on the appearance of the eyelid, conjunctiva, sclera, and cornea. Eyes were also observed for signs of discharge or blepharism.

Epidemiological Descriptions

For the purposes of this document, the ocular conditions that developed are characterized by three categories of clinical signs. The first category consisted of blepharism, blepharospasm, photophobia, ocular discharge, and red eyes or conjunctivitis. These are described from now on as initial clinical signs (ICS). The second category of clinical signs developed months later and was characterized by corneal edema, transient glaucoma, bullous keratitis and severe bilateral corneal opacities similar in appearance to "blue eye". The final category involved the development of mature cataracts and clinical blindness.

Descriptive data for the months during the expression of ICS and the first cases of corneal opacities are based primarily on feeding log reports. Since different individuals with varying degrees of clinical training were making these observations, a criteria based on persistent reporting was established to reduce the possibility of an unreliable report biasing the present descriptions. In evaluating data from the feeding logs, a clinical sign was reported for three or more consecutive days before it was considered an ocular condition of clinical significance. An ocular condition was considered resolved on the date when an individual was either explicitly reported as asymptomatic or after 7 consecutive days with no reported clinical signs.

RESULTS

Development of Initial Clinical Signs

At FFS, 4 seals received reports of either red sclera or eyes, red conjunctiva, or ocular discharge. Reports of red sclera/eyes and red conjunctiva were restricted to the first 2 seals collected. These clinical signs were transient and not reported during entrance veterinary examinations conducted at SLP.

After transport to SLP, 9 seals presented initial clinical signs (ICS) consisting of blepharism, conjunctivitis and/or ocular discharge (Fig. 1). The ICS occurred 12 to 46 days after collection from FFS (mean: 27 days, SE: 4 days) and 7 to 31 days after arrival at SLP (mean: 19 days, SE: 2 days). Following onset, ICS lasted between 16 and 45 days (mean: 30 days, SE: 4 days) followed by apparent resolution. For 8 seals, blepharism was considered the onset of ICS. It should be noted that the ICS period included expression of blepharism, blepharospasm, photophobia, ocular discharge, and/or conjunctivitis. Seals YC14 and YC32

did not meet criteria for ICS but received reports of blepharism in late October 1995. These bouts of blepharism occurred comparatively "late" at 134 and 84 days post-collection.

Development of Corneal Opacities

The 9 seals that displayed ICS developed a second category of clinical signs characterized by corneal opacities (Fig. 2). Opacities occurred 40 to 81 days (mean: 60 days, SE: 4 days) after the resolution of ICS and 109 to 125 days post-collection (mean: 117 days, SE: 2 days; Fig. 1). One exception was seal YC24 that developed opacities 324 days post-capture (322 days following arrival to Oahu). The only clinical sign to precede the opacities of YC24 was a single report of episcleritis that occurred after conjunctival biopsies and aqueous humor aspiration performed in late February 1996. Corneal opacities appeared 92 days after the biopsy procedure.

Corneal opacities were first reported either unilaterally or bilaterally with one eye denser than the opposite eye. Seven of 9 seals manifested initial right unilateral opacities. Following onset, all seals developed bilateral corneal opacities. Corneal edema and total opacity similar to blue eye occurred 14 to 39 days following first detection of opacities (mean: 27 days, SE: 3 days). Seals displayed behavior consistent with substantial visual impairment; leukomas developed during this phase. Seal YC24 did not display blue eye or visual impairment.

Seven seals with corneal opacities also manifested severe bullous and ulcerative keratitis that developed 6 to 27 days after onset of corneal opacities (mean: 15 days, SE: 2 days) and persisted for 12 to 73 days (mean: 38 days, SE: 8 days). It should be noted that the duration of corneal blisters and ulcerations was affected by complicating factors such as self trauma and secondary infection.

Density of corneal opacities varied over time and by individual seal. The 9 seals that displayed blue eye passed through a stage in which the opacities appeared to be diminishing. This first stage of regression occurred 36 to 82 days following onset (mean: 64 days, SE: 5 days) and was followed by an improvement of visual acuity.

Development of Cataracts

Nine seals with corneal opacities displayed a third group of clinical signs associated with development of mature cataracts and clinical blindness. Cataracts occurred 317 to 435 days (mean: 373 days, SE: 16 days) following onset of corneal opacities (Fig. 1). Seal YC32, initially considered clinically normal, developed cataracts 611 days after collection with no evidence of previous ocular disease except transient blepharism (see development of ICS above).

Social Affiliation

Descriptions of seal affiliation are restricted to associations prior to the onset of ICS. By the time corneal opacities emerged, seal associations were so mixed that no meaningful associations are discernible. The first 2 seals to arrive at SLP displayed ICS while together in the Jacuzzi. One additional seal also was diagnosed with ICS while in separation with another seal in the Jacuzzi. The 6 remaining seals displayed ICS 3 to 21 days (mean: 11 days, SE:_3 days) following their first association with one or more seals diagnosed with ICS. The asymptomatic seal had been housed with individuals displaying all categories of ocular clinical signs.

DISCUSSION

Conjunctivitis, keratitis, corneal edema, corneal ulceration, and cataracts have been reported as common ocular diseases in other species of pinnipeds, especially in captivity. Examination of the eyes of 1501 wild seals by Stoskopf et al. (1985) resulted in no evidence of corneal edema/ulceration or keratitis, although corneal scars were common. Corneal opacities have been described in seals and sea lions (Greenwood, 1985). Transient, dense, and extensive corneal edema has been described in pinnipeds associated with ultraviolet light in bright sunshine and the miotic pupil causing endothelial inflammation. The pathogenesis of these conditions is speculative at this point (Bellhorn et al., 1977; Hirst et al., 1983; Stoskopf et al., 1983).

Since initial capture, the presently described monk seals have remained in captivity as a result of three categories of ocular clinical signs. The first manifested by ICS (conjunctivitis, red eyes, and/or ocular discharge), the second by corneal opacities (Fig. 2), and the third by bilateral cataracts and blindness. The temporal distribution of these ocular conditions showed a defined clustering of expression consistent with an outbreak (Fig. 1). Although the development of ICS marked the onset of the ocular problems, opacities and cataracts occurred during consecutive, well-defined timeframes. To date, the etiology of these conditions has not been identified.

It is not known when the ICS manifested for the first time in these monk seals. A field examination with binoculars performed by two veterinarians between 25–31 August 1996 and 8–21 March 1997 at FFS concluded that of the 123 mostly adult monk seals (72 females and 50 males) observed, 21 (17%) showed ophthalmologic problems. Ocular disease included evidence of unilateral or bilateral ocular discharge in 19 seals, 'puffy' eyes in 2 seals, diffuse blue-gray opacities in 6 seals with evidence of trauma. Corneal opacities were observed in 14 seals and ranged in location and nature. Diffuse maculae and nebulas were described in 4 seals, and central well-defined leukomas in 6 seals. Most of these opacities appeared to be trauma related. The opacities in 4 seals were similar to corneal opacities manifested by seal pups in captivity, and their cause could not be determined at the time of the field observations. Two seals demonstrated a condition similar to 'cherry eye' with dark purple coloration resembling melanomas and 1 seal presented papilloma-like lesions on eyelids.

Most seal pups (75%) collected in May 1995 developed ICS within an average of 27 days. Following the onset, these clinical signs lasted approximately 1 month with the development of corneal opacities on average 117 days post-collection (August–September 1995). In most cases, cataracts appeared on average 373 days following collection (May–June 1996). Epidemiologically, there were three well-defined groups of clinical signs related to ocular disease manifested in these captive seals.

ACKNOWLEDGMENTS

The authors would like to recognize R. Boland, M. Breeze, A. Sloan and C. Yoshinaga for their assistance in making observations on the progression of the eye disease. J. Mobley and J. Reif deserve recognition for providing critical reviews and feedback on the manuscript.

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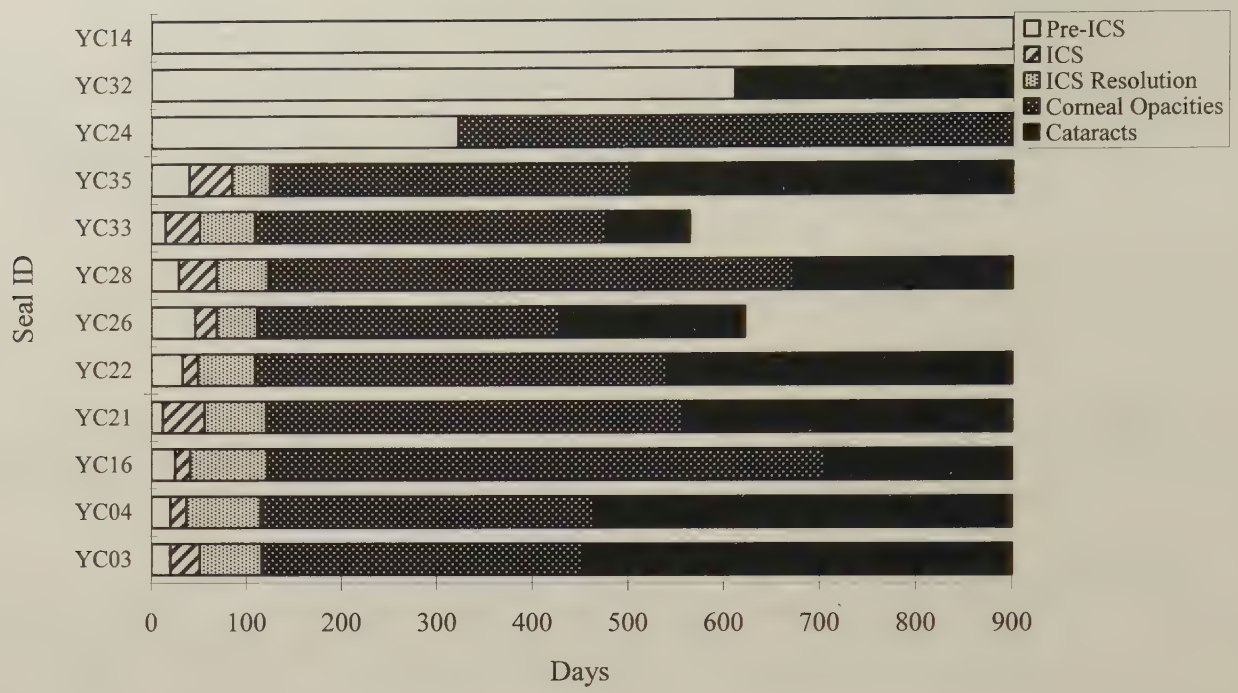

Figure 1.--Time course of initial clinical signs (ICS), corneal opacities and cataracts for each Hawaiian monk seal from date of capture. Seals YC26 and YC33 died in captivity of causes unrelated to the eye disease.

Figure 2.--Corneal edema and total opacity (leukoma) of the eyes similar to "blue eye" occurred 40 to 81 days following the resolution of ICS and 109 to 125 days post-collection, in the captive Hawaiian monk seals (*Monachus schauinslandi*).

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